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CARLOS CASTILLO-CHAVEZ: A CENTURY AHEAD

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When the opportunity to contribute a short essay about Dr. Carlos Castillo-Chavez presented itself in the context of this wonderful birthday celebration my immediate reaction was *por supuesto que sí*! Sixteen years ago, I travelled to Cornell University with my colleague at the National Security Agency (NSA) Barbara Deuink to meet Carlos and hear about his vision to expand the talent pool of mathematicians in our country. Our motivation was very simple. First of all, the Agency relies heavily on mathematicians to carry out its mission. If the U.S. mathematics community is not healthy, NSA is not healthy. Keeping our country safe requires a team of the sharpest minds in the nation to tackle amazing intellectual challenges on a daily basis. Second, the Agency cares deeply about diversity. Within the mathematical sciences, students with advanced degrees from the Chicano, Latino, Native American, and African-American communities are underrepresented. It was clear that addressing this issue would require visionary leadership and a long-term commitment. Carlos had the vision for a program that would provide promising undergraduates from minority communities with an opportunity to gain confidence and expertise through meaningful research experiences while sharing in the excitement of mathematical and scientific discovery. His commitment to the venture was unquestionable and that commitment has not waivered since the inception of the Mathematics and Theoretical Biology Institute (MTBI) in 1996.

The sub-title of this very brief essay, A Century Ahead, has multiple meanings. The most important meaning is the sense of urgency that Carlos brought to MTBI and its mission back in 1996. It was clear to all of us that the day when we no longer needed to speak of underrepresented communities among mathematicians was not a day we would see in the 20^{th} Century. Carlos, however, has never been deterred by the daunting task of working towards this goal. He understands that there is no royal road to geometry and that doctorates in mathematics come one at a time. On the other hand, he also knows that the long journey to a doctorate and a successful career as a researcher is completed more often when a student has a vibrant support group of both peers and mentors. MTBI, from the start, was envisioned to be a family where the core values are high academic standards and mutual support. Carlos reinforces these values constantly. In fact, the sense of urgency that Carlos brings to his mission could be described as a very healthy impatience. He has always been tireless in his recruitment of students for MTBI and aggressive in his search for additional sponsors and academic experts willing to devote their time, energy, and resources to advance the MTBI goals.

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Carlos was A Century Ahead in another very important respect. The best way to understand how is to consider the following words of the famous physicist and mathematician Freeman Dyson:

> *It has become part of the accepted wisdom to say that the twentieth century was the century of physics and the twenty-first century will be the century of biology. Two facts about the coming century are agreed on by almost everyone. Biology is now bigger than physics, as measured by the size of budgets, the size of the workforce, or by the output of major discoveries; and biology is likely to remain the biggest part of science through the twenty-first century. Biology is also more important than physics, as measured by its economic consequences, by its ethical implications, or by its effects on human welfare.*

There is much more to this story, however. The new age of biology that Dyson is speaking of is really an age of convergence in which biology is soaring to new heights on the wings of mathematics, computational sciences, information science, and nanotechnology. The implications of this convergence for both the good of mankind and our national security are profound. The power of mathematics combined with the modern understanding of molecular biology and the digital character of genomic information is producing breakthroughs on a daily basis now. The promise of better foods, better medicines, and better fuels will ensure that a great many of the available resources for new science will be devoted to these areas. This really is the top science story of the new century and Carlos has put every participant of MTBI in a position to be an integral part of this next wave in human achievement. Indeed, the emphasis on mathematics *and* theoretical biology that Carlos chose as the intellectual centerpiece of his research program for young mathematicians was an absolutely brilliant decision. Among mathematicians, Carlos was into biology before biology was cool!

The personal research accomplishments of Carlos and his students on influenza and the modeling of epidemics are of vital importance to the future security of our nation, in particular. While the positive benefits of the century of biology are many, we are also entering a time when synthetic biology will be available to everyone. Do-it-yourself genetic engineering is on the rise and placing the tools of bio-synthesis and bio-engineering into the wrong hands poses enormous risks to the public. We will be relying on the new generation of mathematical biologists that Carlos and his team are mentoring to understand and mitigate these threats.

Having been involved in leading research organizations for the past twenty years, I am used to hearing researchers complain that they lack funding and resources for their work. To a large extent this is certainly true. The pressing and immediate needs of today tend to get most of the available money. However, somewhat ironically, I have also noticed that even during times of serious financial crisis there is plenty of money around to support the development of the truly great ideas. I constantly tell the people who work for me, don't worry about the money, worry about the ideas. Great ideas are always in short supply and I have never seen a great idea go unfunded. Moreover, what it really takes to drive a great idea to a great achievement is commitment. MTBI continues to be a towering example of a great idea *and* a great achievement. This success has been made possible by the passionate commitment that Carlos made 16 years ago and his steadfast dedication to the program ever since. The recognition that his efforts have won from Presidents and the American Mathematical Society are well deserved! The summary of

MTBI milestone achievements included in the essay of Melissa Castillo-Garsow in this volume is absolutely amazing!

Carlos, thank you for being a role model as a mathematician and as a human being. Thank you for your deep and lasting commitment to the intellectual future of our country and your public service as a leading researcher on epidemics and population biology. Most of all, thank you for defining the true standard of excellence in mentoring and talent development through the Mathematics and Theoretical Biology Institute! We look forward to many more years of success in the future! *¡Feliz Cumpleaños!*

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